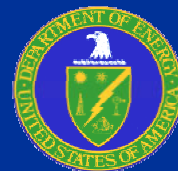


# ENVIRONMENTAL MEASUREMENTS LABORATORY

EML-620



## FY2002 Annual Report



February 2003

## **DISCLAIMER**

“This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability nor responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.”

This report has been reproduced directly from the best available copy.

Available to DOE and DOE Contractors from the Office of Scientific and Technology Information, P.O. Box 62, Oak Ridge, TN 37831; prices available from (423) 576-8401.

Available to the public from the U.S. Department of Commerce, Technology Administration, National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161, (703) 487-4650.

# DIRECTOR'S MESSAGE

I am pleased to present this overview of EML's FY 2002 accomplishments. Our contributions in the fields of radiation and radioactivity measurements, science and technology for environmental cleanup, and national defense demonstrate the significant role EML played in contributing to the missions of the Office of Environmental Management, Office of Science and Technology (EM/OST) and to those missions across the DOE complex. We challenged ourselves and succeeded in meeting the aggressive goals we set before us.

In FY 2002, EML was designated to become part of the new Department of Homeland Security. EML's distinguished 55-year history puts the Laboratory in a unique position to make significant contributions to the new Department's mission to protect and secure our nation. To meet this new mission, EML will build upon its long-standing capabilities in radiation detection and radioactivity measurements. We also recognize the significance of our New York urban location and will work closely with local and regional organizations that are responsible for security of the region. As we continue to move forward in our transition, I am confident that, individually and collectively, we will rise to meet even greater challenges. We stand ready to serve and are committed to continue our tradition of excellence.

A handwritten signature in black ink, reading "Mitchell D. Erickson". The signature is written in a cursive, flowing style.

Mitchell D. Erickson, Director  
Environmental Measurements Laboratory

# EML FY 2002 Annual Report

## TABLE OF CONTENTS

<b>EML'S IMPACT.....</b>	<b>1</b>
<b>OUR CUSTOMERS AND FUNDING.....</b>	<b>1</b>
<b>ENVIRONMENTAL RADIATION &amp; RADIOACTIVITY MEASUREMENTS.....</b>	<b>2</b>
<b>QUALITY ASSURANCE ACTIVITIES .....</b>	<b>2</b>
Quality Assessment Program (QAP).....	2
Radiological Traceability Program (RTP).....	3
Environmental Management Performance Evaluation Programs (EMPEP) .....	3
International Environmental Dosimetry Intercomparison Program.....	4
<i>In Situ</i> Gamma-Ray Spectrometry Intercomparison Program .....	5
<b>INSTRUMENTS AND METHODS DEVELOPMENT.....</b>	<b>6</b>
EML/NIST Americium Alpha Spectral Analysis Study .....	6
Kinetic Phosphorescence Analyzer (KPA).....	6
Inductively Coupled Plasma/Mass Spectrometry (ICP/MS) at EML .....	7
Calculation of Sample Strontium-90 Activity and Half-Life Range of Acceptance for Radiometric Purity of Yttrium-90 .....	7
Applications of a Large Diameter Germanium Detector .....	8
Analysis of Haddam Neck Nuclear Power Plant Environmental Water Samples .....	8
EML Procedures Manual (HASL-300).....	9
Patent Applications .....	9
Standards Development .....	9
ANSI-N13.37: American National Standard for Environmental Thermoluminescent Dosimeters .....	9
ANSI N42.28: <i>In Situ</i> Gamma-Ray Spectrometry.....	9
Atmospheric Cosmic Radiation and Neutron Spectrometry .....	10
RAMP Systems Upgrade.....	10

<b>FIELD TECHNICAL SUPPORT .....</b>	<b>11</b>
FEMP- Real Time Measurement Program.....	11
FEMP- Radon/Thoron Progeny Monitor Calibration .....	11
BNL - TLD Monitoring.....	12
MEMP - Contaminant Characterization .....	12
MEMP - <i>In-Situ</i> Pu-238 Measurements .....	12
AEMP - Measurement and Sampling Strategies .....	13
West Valley Demonstration Project Characterization Plan .....	13
ETTP - Real Time Measurement Technologies .....	13
<b>NATIONAL AND HOMELAND SECURITY .....</b>	<b>15</b>
<b>NATIONAL SECURITY .....</b>	<b>15</b>
International Monitoring Systems Laboratory (IMS).....	15
EML's Global Network.....	16
EML Collaborates With World Meteorological Organization's Global Atmosphere Watch .....	16
High-Altitude Sampling Program Archive .....	17
<b>HOMELAND SECURITY .....</b>	<b>18</b>
Emergency Preparedness.....	18
Development of Standards and Roadmaps .....	18
Portable Aerosol Sampling System (PASS).....	19
EML Homeland Security Monitoring Platform.....	19
Comprehensive Radiation Sensor (CRS) .....	20
Real Time Gamma-Ray Spectrum Analysis.....	21
NaI Based Neutron Detection.....	21
Characterization of Plumes Passing Over Lower Manhattan After the World Trade Center Disaster .....	22
Impact of the World Trade Center Collapse on Hudson River/ New York Harbor.....	23
<b>CONSULTATION, PROGRAM MANAGEMENT, AND PROGRAM COORDINATION.....</b>	<b>24</b>
Human Subjects Research Database (HSRD).....	24
Special Assistance to the DOE Protecting Human Subjects Program.....	25
D&D Science Consortium.....	25
EM Headquarters – EML Liaison.....	25
Cleanup Criteria/Decision Document (C2D2) Database .....	26
Validation of Subsurface Bayesian Geostatistical Survey Analysis.....	27
Radiological Evaluation Assistance .....	27

Characterization, Monitoring and Sensor Technology Cross-Cutting Program (CMST-CP) .....	27
Joint Coordinating Committee on Environmental Restoration and Waste Management (JCCEM) .....	28
Interstate Technology and Regulatory Cooperation (ITRC) Coalition .....	28
US Transuranium and Uranium Registries (USTUR) Advisory Committee .....	28
Textbook on Radioanalytical Chemistry .....	29
Strategic Environmental Research and Development Program (SERDP) .....	29
Interagency Arctic Research Policy Committee (IARPC) .....	29
<b>AWARDS AND RECOGNITION .....</b>	<b>30</b>
EML Scientist Receives Japanese Research Award .....	30
EML Scientist Awarded Patent .....	30
<b>STAFF ACTIVITIES .....</b>	<b>31</b>
Visiting Scientists .....	32
Technical Seminars by Visiting Scientists .....	32
Technical Presentations by EML Staff .....	33
Presentations at Scientific Meetings .....	33
Training .....	37
Academic Affiliations and Activities .....	37
Committee and Outside Coordination Activities (National and International) .....	37
Professional Society Activities .....	39
Standards Activities .....	39
Meetings Organized and Sessions Chaired .....	40
Publications .....	41

# EML'S IMPACT

EML is a world-renowned radiation and radioactivity technology federal resource that provides DOE with a readily available and objective in-house capability in support of its unique and special requirements. With a distinguished 55-year reputation for excellence in low-level environmental radiation and radioactivity measurements, the Laboratory plays a vital role in consultation and program management, field technical assistance and support, instruments and methods development, and data quality assurance. These capabilities are applied to environmental restoration, global nuclear non-proliferation and other national security and priority issues for the Department of Energy as well as for other government, national and international organizations.

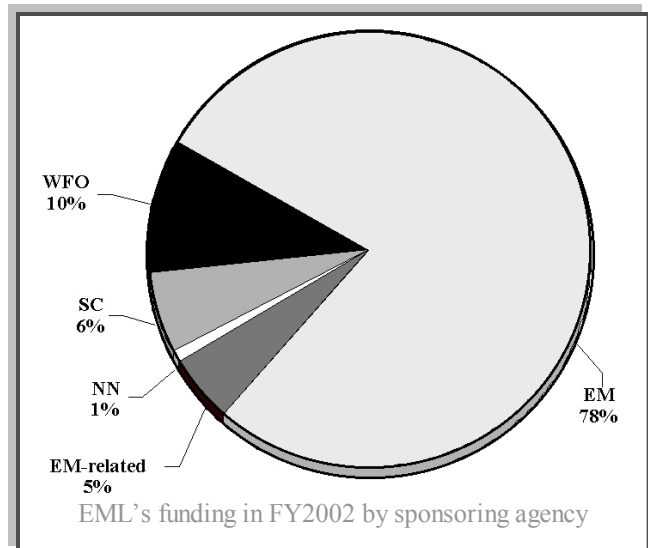
## OUR CUSTOMERS AND FUNDING

EML's long-standing reputation has led to its staff being called upon for assistance and consultation to fulfill special needs within the scientific community not only across the DOE complex, but at other institutions throughout the world, including government agencies, national laboratories, and universities.

In FY 2002, EML's primary mission was to support its main customer, the DOE Office of Environmental Management (EM), in its site closure and cleanup efforts through technical assistance in cleanup criteria, radiation survey planning, development of radiological field characterization and monitoring technologies, and external oversight of the quality of data used in these activities.

EML also provided assistance to DOE's Office of Science (SC) and the National Nuclear Security Administration (NNSA) in support of their special and unique requirements.

The staff's collective expertise resulted in an expansion of its role to projects under a Work for Others (WFO) Program. EML's WFO customers included the Air Force (AF), Nuclear Regulatory Commission (NRC), Environmental Protection Agency (EPA), National Aeronautics and Space Administration (NASA), Defense Threat Reduction Agency (DTRA), and International Business Machines (IBM).



# ENVIRONMENTAL RADIATION & RADIOACTIVITY MEASUREMENTS

**Quality data—fundamental to saving time and money and protecting health**

## QUALITY ASSURANCE ACTIVITIES

*EML's quality assurance (QA) activities support EM's site closure and cleanup efforts by assessing the quality of environmental radiation and radiological measurements. Accurate and precise field and analytical data is essential for important characterization, remediation, and long-term monitoring decisions. Defensible data allows program managers to make better and more cost effective decisions, which translate into cost savings and a healthier environment for cleanup workers and the public. For example, the technologies that are most appropriate for a given cleanup problem are determined in large part by the extent of the radiological contamination and how accurately it is measured.*

*Independent external QA programs are a prime example of EML's services to EM and other government, national and international organizations. EML is known around the world for its testing and intercomparison programs.*

### Quality Assessment Program (QAP) EM

The goal of QAP is to provide a standardized procedure for DOE contractor and subcontractor laboratories to substantiate their ability to analyze low-level radionuclides at cleanup sites. Laboratories routinely analyze soil, water, vegetation and air filter samples from DOE sites, determining the type and quantity of gamma, alpha and beta emitting radionuclides present to meet cleanup criteria.

Twenty-six laboratories participated in the first QAP in 1976. More than 170 laboratories received samples in the most recent QAP. A summary evaluation is available to the participants, DOE managers, and stakeholders via the EML web site 48 hours after the reporting deadline. In FY 2002,



Preparation of air filters for QAP



EML successfully completed the 55<sup>th</sup> and 56<sup>th</sup> QAP and published the results as EML Reports 615 and 617, both of which are available on-line. The program, including examples of the uses of the database by the Sample Office Managers, contractor laboratories and the scientific community, was highlighted at the National Analytical Management Program (NAMP) meeting in Las Vegas, NV, September 9-13, 2002, in a presentation on “The Use of EML’s QAP Data in Accelerating the EM Cleanup Program.”

*(Anna.Berne@eml.doe.gov)*

### **Radiological Traceability Program (RTP)**

EM

EML continues to serve as a Reference Laboratory for the DOE Radiological Traceability Program (RTP). The National Analytical Management Program (NAMP) established the RTP to provide traceability through QAP to NIST for DOE contractor laboratories. Reference Laboratory status means that EML is directly traceable to the National Institute of Standards and Technology (NIST) for both the preparation and the characterization of performance evaluation (PE) materials, as described in ANSI N42.23. The process of establishing traceability consists of periodic exchange of materials and the results of their analysis for selected types of radionuclides with NIST, followed by evaluation of these results using ANSI N42.22 acceptance criteria as a guide. In FY2002, traceability to NIST was established for the preparation and characterization of water, soil and simulated air filter PE materials. *(Anna.Berne@eml.doe.gov)*

### **Environmental Management Performance Evaluation Programs (EMPEP)**

EM

In February 2002, the NAMP Steering Committee (SC) approved the establishment of a working group to develop the Quantitative Laboratory Performance Evaluation Program description document. The SC recommended that EML be selected as a member of that group. During the bimonthly conference calls, the outline of the document proposed by the SC was discussed and modified, with the understanding that the goal of the document was to provide the first high-level description of the DOE/EM PE programs. These programs support environmental cleanup across the DOE complex and assure stakeholders and regulators that the analyses conducted by EM funded programs and projects meet established and project-specific requirements. The basis for PE programs, and the integrated PE framework for the quantitative performance evaluation are described as a system providing information used by project managers, program managers and regulators regarding site closure, site completion, long-term stewardship, risk assessment, and human health and safety.

As of September 30, 2002, the first draft of the document titled “Environmental Management Performance Evaluation Programs – A Framework for Assuring Quality

Data” was completed and a schedule for final development and internal and external review was proposed. (*Anna.Berne@eml.doe.gov*)

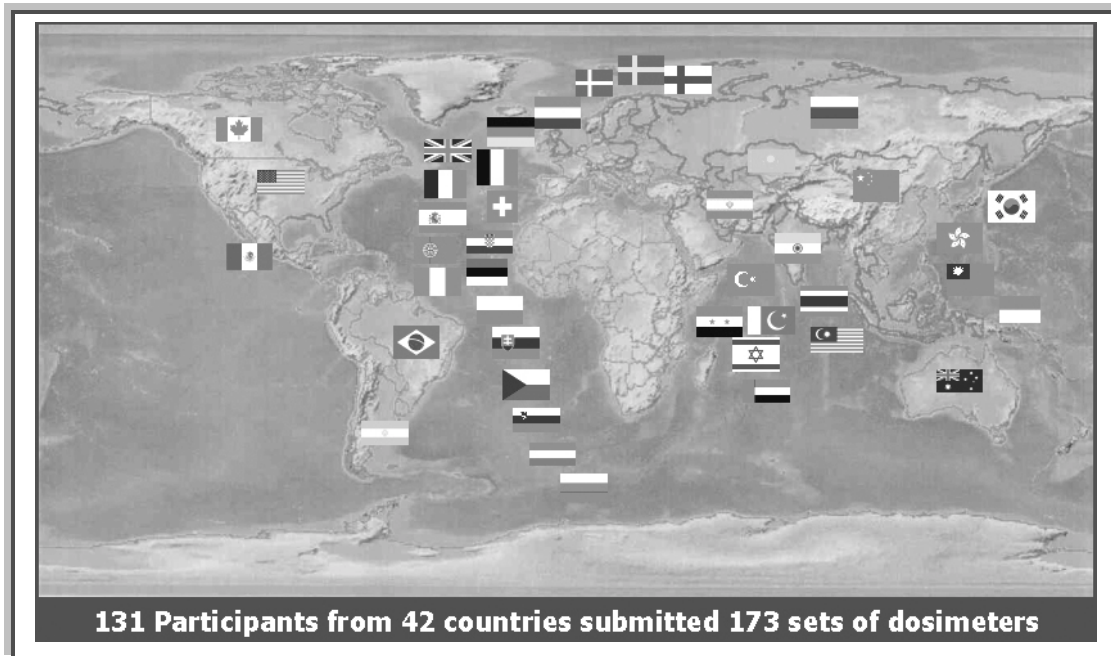
## **International Environmental Dosimetry Intercomparison Program**

### **EM**

For over 28 years EML has led an effort to provide quality assurance in environmental dosimetry through its International Intercomparisons of Environmental Dosimetry. These voluntary intercomparisons allow the participants to gauge their performance and test newly developed procedures or technologies. The intercomparisons have also been instrumental in identifying and addressing issues in environmental dosimetry.

EML completed the investigation of the results of the 12<sup>th</sup> International Intercomparison of Environmental Dosimeters during FY 2002. This intercomparison was conducted with the collaboration of colleagues at the National Institute of Standards and Technology (NIST), Brookhaven National Laboratory (BNL) and International Atomic Energy Agency (IAEA) and was held at BNL in 2000. The intercomparison was designed based on aspects of the Draft ANSI Standard N13.29 (“Environmental Dosimetry Performance Criteria for Testing”) to evaluate the dosimeters when exposed to laboratory, field and a combination of both sources. The results were similar to past intercomparison with 55% and 83% of the laboratory and field exposed dosimeters, respectively, meeting the ANSI N545 criteria. Among the combined field and laboratory exposed dosimeters, there was slight improvement in performance when the laboratory exposure occurred near the end of the field period.

An invited presentation of the results was given at the Harshaw TLD Users Group Meeting in May 2002 in San Antonio, TX. The results are also being prepared as an internet-based summary that will be accessible to all participants and others. In addition, a scientific publication of results is also in preparation. (*Matthew.Monetti@eml.doe.gov*)



## ***In Situ* Gamma-Ray Spectrometry Intercomparison Program**

### EM

In FY 2000, EML and the Environmental Protection Agency's Office of Radiation and Indoor Air (ORIA) staged an *in situ* spectrometry intercomparison in Grand Junction, CO. It featured measurements of a background location and the Walker Field Calibration Pads. The participants made simultaneous and sequential co-located *in situ* measurements using HPGe detectors. The primary objectives of this intercomparison were to compare the result of the participants to each other and to soil samples, and to evaluate the Walker Field Calibration Pads as a potential standard for *in situ* measurements.

In FY 2002, a final draft of the results was completed and a paper on the Intercomparison was submitted for publication in the journal Health Physics. The results reinforced the generally good agreement between soil samples and *in situ* measurements for naturally occurring gamma-emitting radionuclides in surface soil. The results also demonstrated that the Walker Field Calibration Pads cannot be used as a standard for *in situ* measurements of  $^{226}\text{Ra}$  without measurements of the  $^{222}\text{Rn}$  exhalation.  
(*Peter.Shebell@eml.doe.gov*)

## **INSTRUMENTS AND METHODS DEVELOPMENT**

### **Low-level Radiation Detection and Measurements Instruments**

*EML has a long history of developing low-level radiation detection and measurement instruments for small niche, customer-specific requests and as modifications of commercial off-the-shelf products. Some of these instruments have resulted in commercial products. EML's efforts in technology development are applied to EM characterization and monitoring for long-term stewardship programs. EML also develops methodology for environmental sampling, low-level radiation field measurements, and analytical determination of radionuclide contents in air, soil, water, diet, tissue, and other media.*

### **EML/NIST Americium Alpha Spectral Analysis Study**

EM

As the need to determine  $^{241}\text{Am}$  in environmental samples at DOE sites continues to grow, alpha spectrometry continues to be the method of choice for quantifying low-level contamination. However, when using alpha spectrometry to measure the ratio of  $^{243}\text{Am}$  (added as a tracer) to  $^{241}\text{Am}$ , the overlap of the two peaks in the spectrum has to be resolved accurately for the data to be reliable. A study to evaluate several techniques (algorithms) for the analysis of alpha spectra with overlapping peaks is being conducted in collaboration with NIST. In FY 2002, an additional phase of the study was conducted which was designed to investigate the variability of results obtained from replicate samples prepared under the same experimental conditions. The spectra obtained in this phase were also analyzed using an algorithm in use at the Institute for Reference Materials and Measurements (IRMM) in Retieseweg, Belgium. One-way analysis of variance (multifactor ANOVA) was applied to the results obtained from counting replicate samples. In almost every case, at least one sample was statistically different from the other two. To identify a possible source of variability, radiograph images of some electroplated samples and electron microscope images of Pt-coated microprecipitated samples were evaluated. A summary of these results and conclusions will be submitted for publication in a peer review journal.

*(Anna.Berne@eml.doe.gov)*

### **Kinetic Phosphorescence Analyzer (KPA)**

EM

The Kinetic Phosphorescence Analyzer (Model KPA-11, Chemchek Instruments, Inc.), a bench top, computer-controlled instrument, is used at EML as an alternative method for the measurement of total uranium in liquid samples. The methodology is based on laser excitation of a uranium-bearing solution, followed by time resolution of the phosphorescence signal. The accuracy and precision of the KPA for total uranium measurements was evaluated by analyzing QAP water and well water samples by three independent methods, namely KPA, ICP/MS and alpha spectrometry. The results of the

evaluation were presented at the 48<sup>th</sup> Annual Conference on Bioassay, Analytical and Environmental Radiochemistry (BAER) in Las Vegas, Nevada.  
([Ada.Kong@eml.doe.gov](mailto:Ada.Kong@eml.doe.gov))

### **Inductively Coupled Plasma/Mass Spectrometry (ICP/MS) at EML** EM

EML's Inductively Coupled Plasma Mass Spectrometry (ICP/MS) facility is equipped with a ThermoElemental PQ Excel mass spectrometer and specialized sample introduction devices such as low flow desolvating nebulizers, ultrasonic nebulizers, and flow injection systems. The primary use of this instrument is to analyze environmental



EML's ICP/MS facility

soil, vegetation, air filter and water samples for uranium and plutonium isotopes. These two elements can be quantified with good accuracy and precision down to very low levels, i.e., a few tens of femtograms. Work is now in progress to develop the capability to measure the nuclear fission product isotopes <sup>135</sup>Cs and <sup>135</sup>Cs at levels typically present in environmental samples.  
([John.Kada@eml.doe.gov](mailto:John.Kada@eml.doe.gov))

### **Calculation of Sample Strontium-90 Activity and Half-Life Range of Acceptance for Radiometric Purity of Yttrium-90** EM

An improved programmed Excel spread sheet has been developed as a calculation template for the determination of fission product <sup>90</sup>Sr, by measurement of its <sup>90</sup>Y progeny, in Quality Assessment Program (QAP) and other environmental samples. All radiochemical analysis information, radioassay data and calculations have been consolidated into a single electronic record. The workbook, consisting of several worksheets, also flags quality problems and provides a complete audit trail for QA review.

The workbook contains a linear least squares regression program method for establishing the limits for acceptance or rejection of sample radiometric purity. The sample <sup>90</sup>Y half

life with its associated error is calculated from the counting data and is automatically compared to an acceptance range obtained from an empirically determined error curve. The error curve, based on the initial sample beta activity, was derived from the historic QAP analysis results database and  $^{90}\text{Y}$  standards.

*(Raymond.Lagomarsino@eml.doe.gov)*

## **Applications of a Large Diameter Germanium Detector**

EM

A unique germanium detector system has been calibrated for applications involving measurements of soil, particularly for  $^{241}\text{Am}$ .

The state-of-the-art 1-inch diameter well detector was successfully employed for the determination of the homogeneity of Quality Assessment Program (QAP) soil and vegetation samples. Routinely, QAP sample homogeneity determinations are made with sample aliquots of >50 grams. The well sample volume (15 mL) allows homogeneity determinations at sample weight ranges (<20 grams) used for radiochemical analyses

Gamma analyses of two  $^{243}\text{Am}$  internal standards employed for recoveries of  $^{241}\text{Am}$  from radiochemical analyses of QAP samples indicated that the gamma assay values were ~15% higher than the values affixed to the solution. Restandardization of the internal standards resulted in  $^{243}\text{Am}$  values which were in excellent agreement with the gamma results.

A method for the rapid dissolution of neodymium fluoride microprecipitates containing  $^{241,243}\text{Am}$  was developed. Quantitative recoveries of both radionuclides were verified by the large well detector.

*(Raymond.Lagomarsino@eml.doe.gov)*

## **Analysis of Haddam Neck Nuclear Power Plant Environmental Water Samples**

NRC

A radioassay method for  $^{241}\text{Pu}$  in water was developed for samples submitted for analysis by the Nuclear Regulatory Commission (NRC). The samples were collected as part of the environmental survey for the decommissioning of the Connecticut Yankee Power Plant. Sample plutonium activities ( $^{238,239,240}\text{Pu}$ ) were determined by alpha spectrometry using a microprecipitation source that was prepared as described in HASL-300 (G-03, Vol. 1). After the alpha spectrometric radioassay had been completed, the neodymium fluoride microprecipitate was quantitatively dissolved and the  $^{241}\text{Pu}$  activity determined by liquid scintillation spectrometry.

*(Raymond.Lagomarsino@eml.doe.gov)*

## **EML Procedures Manual (HASL-300)**

EM

HASL-300 was first issued in 1957. As the mission of EML evolved over time, new methods, including field collection and sampling methods, were added to the manual. Now in its 28<sup>th</sup> Edition, HASL-300 remains a comprehensive and readily available resource for the scientific community. Updates and additions to the HASL-300 are made directly on EML's web site. The manual is also available on CD-ROM upon request.

*(Isabel.Fisenne@eml.doe.gov)*

## **Patent Applications**

EM

IN FY 2002, a patent application was prepared and submitted for the Cesium 2k Analyzer, a custom instrument for counting Cesium Rad Disks. A patent application is also undergoing review at the Patent Office for the EML designed AUTORAMP, a fully automated and completely unattended gamma-ray analysis system that filters air on HEPA medium after which resultant spectra are immediately transmitted to a data center via satellite or telephone.

*(Norman.Latner@eml.doe.gov)*

## **Standards Development**

EM

### ***ANSI-N13.37: American National Standard for Environmental Thermoluminescent Dosimeters***

EML chairs the American National Standards Institute (ANSI) Standard N13.37 committee developing procedures for the use of thermoluminescence dosimeters (TLDs) in environmental applications. The third draft of N13.37 is presently under development and is intended to replace ANSI-N545. The N13.37 committee includes experts from the Nuclear Regulatory Commission, the National Institute of Standards and Technology, the Department of Energy, academia, and industry.

*(Gladys.Klemic@eml.doe.gov)*

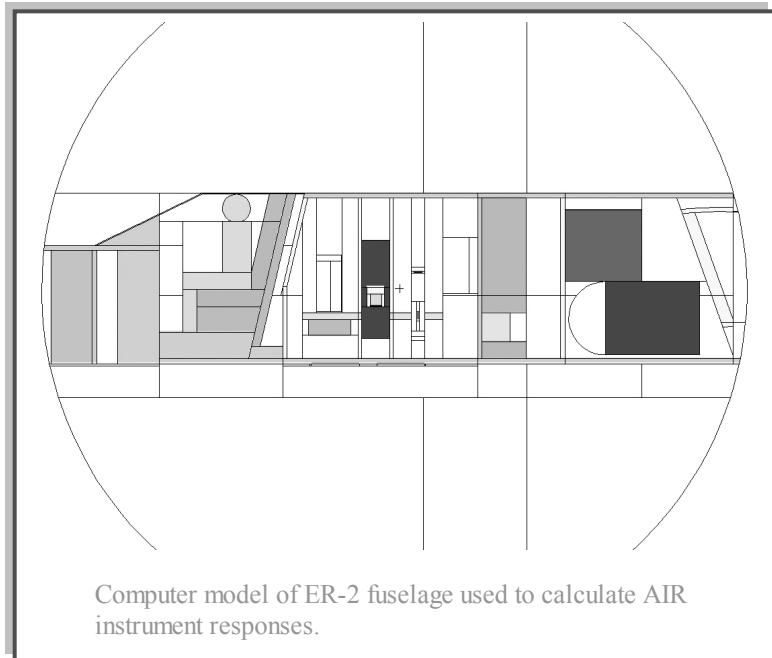
### ***ANSI N42.28: In-Situ Gamma-Ray Spectrometry***

EML is a member of the ANSI N42.rm sub-committee that develops standards related to radiation measurements. EML also co-chairs with INEEL a writing group developing ANSI N42.28, "Performance Standard for the Calibration of Germanium Detectors for *In-Situ* Gamma-Ray Measurements." In FY 2002, N42.28 was submitted for final ballot and is expected to be approved in FY 2003.

*(Peter.Shebell@eml.doe.gov)*

## Atmospheric Cosmic Radiation and Neutron Spectrometry NASA

Neutron spectrometry (measuring the energy distribution of neutron radiation) is essential for understanding the negative effects of neutron radiation on human health and on the reliability of digital electronics. The EML multisphere neutron spectrometer was the primary instrument used in the international Atmospheric Ionizing Radiation (AIR) Project to determine doses from cosmic radiation,



especially neutrons, to occupants of high-altitude aircraft. In FY 2002, the National Aeronautics and Space Administration (NASA) awarded EML a 2-year grant to complete analysis of the AIR measurements and use them to validate a new computer model of AIR to be developed in collaboration with the University of Delaware and the NASA Langley Research Center. Results from this project can be used to understand neutron-induced "single-event effects" on microelectronics and the background for detecting neutrons from clandestine nuclear material as well as to determine radiation doses to air crew. EML's research in these areas was recognized this year by invitations to give a presentation at the November 2002 meeting of the American Nuclear Society, to write a paper on cosmic-ray neutrons for the Materials Research Society Bulletin and to become a member of the International Organization for Standardization (ISO) Working Group 21 to write a standard on Dosimetry for Exposure to Cosmic Radiation in Civilian Aircraft. *(Paul.Goldhagen@eml.doe.gov)*

## RAMP Systems Upgrade NN

After the successful installation on Mt. Waliguan of the first RAMP system in China, and the initiation of future plans for installations in China and Japan, work was undertaken and completed on an updated RAMP system. The new version replaces the original notebook computer with an inexpensive desk-top type and substitutes an off-the-shelf Universal Power Supply (UPS) for EML's hand-built power supply. These changes will save several thousand dollars per installation.

*(Norman.Latner@eml.doe.gov; Norman.Chiu@eml.doe.gov)*



## **FIELD TECHNICAL SUPPORT**

### **Federal Technical Experts – Service Through Science**

*As federal technical experts, EML supports EM cleanup and closure activities at DOE sites by demonstrating and deploying advanced radiological measurement and survey methods; by assisting in the collection, interpretation, and modeling of radioactive contaminant data in special low-level (at or near background) situations; and by promoting regulatory and industry acceptance of field radiation measurement technologies.*

### **FEMP - Real Time Measurement Program**

EM

EML continued to assist the FEMP (formerly known as the Feed Materials Plant) in its Real Time Measurement Program. Field measurements to support soil excavation control and pre-certification of cleanup operations are performed in this program using *in situ* spectrometry systems. In FY 2002, EML provided a software application for trench geometry corrections as applied to measurements performed with the latest instrument platform, the Excavator Mounted System (EMS). EML also provided technical input and reviews relating to NaI detector counting statistics, minimum detectable concentrations, gain tracking for spectrum stability, guidance for the site operations User's Manual, and error propagation for corrections that are applied for atmospheric radon interference and radium progeny equilibrium in surface soil. The Real Time Measurement Program at the FEMP has been exemplary in the DOE-EM community in providing a systems-based approach for achieving rapid turn around time and nuclide-specific measurements that can support cleanup schedules.

*(Kevin.Miller@eml.doe.gov)*

### **FEMP – Radon/Thoron Progeny Monitor Calibration**

EM

FEMP processed uranium ore and ore concentrates into materials needed in the nuclear weapons production process. The major contaminants on this site are uranium and thorium. Of particular concern are mill tailings stored in large cylindrical structures called silos. Radon, a colorless, odorless, radioactive gas, is a decay product of uranium, and is a major hazard; radon from the silos was once the major emission from FEMP. Radon decays into chemically active and radioactive compounds that can be deposited onto sensitive lung tissues and increase the risk of lung cancer. Exposure to radon progeny must be monitored to insure that it is below regulatory requirements both on site and for off-site emissions. FEMP radon progeny monitors are calibrated annually in the EML Environmental Chamber as part of a routine quality assurance program to insure that FEMP workers and the public are adequately protected.

*(Alfred.Cavallo@eml.doe.gov)*

## **BNL – TLD Monitoring**

### **EM**

Since 1997, EML had been assisting BNL by providing TLD expertise and supplies necessary to monitor the Building 650 Sump Outfall Area. EML provided assistance to perform quarterly TLD monitoring to measure ionizing radiation. The monitoring was stipulated in the Interim Monitoring Plan for this location to provide assurance that the gamma-emitting contaminants did not migrate to any appreciable extent. When remediation of this location began during FY 2002, TLD monitoring was discontinued.  
(*Matthew.Monetti@eml.doe.gov*)

## **MEMP - Contaminant Characterization**

### **EM**

The Miamisburg Closure Project (MCP) requested technical assistance from DOE-EM to lend support in characterizing the following areas: (1) contamination including soils, piping, and concrete pads under WD, 38, HH, SW, and R Buildings; (2) soil and groundwater contamination; (3) buried objects; and (4) underground piping between buildings, including storm and sanitary lines. EML participated on a technical assistance team. The team made a number of recommendations to DOE-MCP. These suggestions were incorporated in the report, “Recommendations to Address Uncertainties in Characterization and Delineation of Contamination at the Miamisburg Closure Project.”  
(*Carl.Gogolak@eml.doe.gov*)

## **MEMP – In Situ Pu-238**

### **Measurements**

### **EM**

A principal contaminant of concern in soil at the Miamisburg Environmental Management Project (MEMP) is  $^{238}\text{Pu}$ . Cleanup criteria require the measurement of this nuclide at levels of 50 pCi/g which is beyond the capabilities of a FIDLER, the normal instrument used for Pu scans in the field. To achieve the required measurement sensitivity, EML has championed the use of Xe-filled Large Area Proportional Counters (LAPC) operated as x-ray spectrometers in the energy range of 10 to 30 keV. In FY 2002, EML teamed with INEEL to demonstrate



AXISS – Actinide x-ray in-situ scanning system

this technology at the MEMP. EML's LAPC was configured by INEEL in a mobile scanning system featuring Global Positioning System (GPS) and software mapping capabilities similar to the mobile gamma-ray spectrometry platforms developed for the FEMP. Tests at the MEMP will be performed in FY 2003 to optimize system performance and demonstrate comparability with laboratory analyses of soil samples. *(Kevin.Miller@eml.doe.gov)*

## **AEMP – Measurement and Sampling Strategies**

EM

The Ashtabula Environmental Management Project (AEMP) at Department of Energy-OH (DOE-OH) requested technical assistance from EM-50 to aid in defining new cost and time effective approaches in the following problem areas: soils, concrete, and groundwater/Corrective Action Management Unit (CAMU) at RMIES in Ashtabula, Ohio. EML participated on the technical assistance team assembled for this request. The team reviewed key site information prior to convening with DOE and contractor personnel (RMIES and Earthline) to better understand baseline technologies, limitations, and site-specific issues. After listening to presentations about the nature and extent of known contamination, the team broke out into several groups to brainstorm ideas, develop viable solutions, and prepare a report, "Recommendations to Address Contaminated Soils, Concrete, and Corrective Action Management Unit/Groundwater Contamination at Ashtabula, Ohio." *(Carl.Gogolak@eml.doe.gov)*

## **West Valley Demonstration Project Characterization Plan**

EM

EML participated on a review team coordinated by Westinghouse Safety Management Solutions. This team conducted an independent third party peer review of the content of WVDP-403 Characterization Management Plan for the Facility Characterization Project, and three radioisotope inventory documents prepared as examples of the WVDP-403 process, all of which were prepared by West Valley Nuclear Services Company. The "Report of the Independent Peer Review of the WVNSCO Facility Characterization Management Plan and Related Radioisotope Inventory Documents" was delivered at the end of FY 2002. *(Carl.Gogolak@eml.doe.gov)*

## **ETTP – Real Time Measurement Technologies**

EM

At the request of the Oak Ridge Site Technology Coordination Group, EML served as a member on a technical assistance team to evaluate the suitability of the Integrated Technology Suite for use as a screening technology to replace conventional field sampling and analysis at East Tennessee Technology Park (ETTP) at the Oak Ridge Reservation. Also, the team was asked to identify the existing technology data gaps and

recommend what should be done during limited field studies funded by the Accelerated Site Technology Deployment program for FY 2002. The team's findings were summarized in the report, "Use of Field Portable Gamma Spectrometry for Free Release at DOE Facilities: Recommendations for Application of the Integrated Technology Suite at East Tennessee Technology Park Oak Ridge, Tennessee."  
*(Peter.Shebell@eml.doe.gov)*

# NATIONAL AND HOMELAND SECURITY

**Radionuclides – Fundamental to detecting proliferation activities, serving as atmospheric tracers for interdiction and response**

*EML carries out research and development of field and laboratory based advanced analytical instruments and technologies, coupled with current techniques in sample collection and analysis and data reduction, to identify nuclear and radioactive threats throughout the world, and to provide advice and consultation on environmental measurements and signatures.*

## NATIONAL SECURITY

### **International Monitoring Systems Laboratory (IMS) DTRA**

EML, in accordance with the requirements of the Provisional Technical Secretariat of the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), has established a dedicated Radionuclide Laboratory to perform radiochemical measurements in support of the treaties. Two high efficiency, high resolution gamma spectrometry systems



were initially installed and calibrated for dedicated use in this laboratory. Recently, two additional Germanium well detectors, along with shields, platform, equipment racks, and NIM electronics, were installed in the IMS Laboratory. Both units were tested and calibrated. Data derived from these four detectors is transmitted to Vienna via a VSAT communication system for secure communication with the CTBTO.

*(Norman.Latner@eml.doe.gov; Norman.Chiu@eml.doe.gov)*

## EML's Global Network

NN

EML maintains a global network of aerosol sampling stations and deposition collection stations. EML added two new SASP sites in China: at Mount Waliguan, Qinghai province and at Guiyang, Guizhou province. Aerosol samples are regularly collected and sent

to EML to be analyzed by gamma-ray spectrometry. The deposition samples are incorporated into EML's sample archive and are available for analysis as the need arises. Data from the network is used to model the distribution and transport of natural and anthropogenic radionuclides in the atmosphere.

*(Fabien.Raccach@eml.doe.gov; Matthew.Monetti@eml.doe.gov)*



Staff Scientists at EML's Mount Waliguan, China, Monitoring Station.

## EML Collaborates With World Meteorological Organization's Global Atmosphere Watch

NN

The World Meteorological Organization's (WMO) Global Atmosphere Watch (GAW) Program has designated EML as the World Calibration Center for Radioactivity. GAW is a coordinated network of meteorological stations and related facilities whose purpose and long-term goal is to provide data, scientific assessments, and other information on changes in the chemical composition and related physical characteristics of the atmosphere from all parts of the



Visit to the World Meteorological Organization  
(left to right: Dr. Leonard A. Barrie and Dr. Hsi-Na Lee)

globe. In FY 2002, Dr. Hsi-Na (Sam) Lee of EML visited Dr. Leonard A. Barrie, Chief of the Environment Division, Atmospheric Research and Environment Programme Department, WMO in Geneva, Switzerland, to discuss the strategic plans of GAW and future collaborations, including the organization of an international workshop. EML has initiated plans to add another monitoring station at Ryori, a GAW site in Japan.  
(*Sam.Lee@eml.doe.gov*)

### **High-Altitude Sampling Program Archive**

NN

EML provided environmental air filter samples to the University of California, Irvine from the EML Environmental Sample Archive. The filters provided were samples collected in 1973 during the High-Altitude Sampling Program (HASP). This program's original purpose was to track the global dispersion of radioactive debris in the stratosphere resulting from atmospheric nuclear testing. Researchers at UC Irvine were interested in analyzing the samples for sulfur isotopes. Since sulfur analysis was not the original intent of the HASP, blank filter material and all available sampling data were also provided to the university. For more information about the High-Altitude Sampling Program and the Archive visit: <http://www.eml.doe.gov/databases/hasp/>.  
(*Robert.Leifer@eml.doe.gov, Ethel.Jacob@eml.doe.gov*)

## **HOMELAND SECURITY**

*Much of EML's research and development and scientific expertise have particular and direct application to homeland security. In the aftermath of the September 11, 2001 attack on the World Trade Center, EML became involved in several Homeland Security initiatives.*

### **Emergency Preparedness**

EML has an established 55-year reputation and capability for fast response and expertise in low-level radioactivity and radiation measurements and techniques which are vitally important in recovery operations. The following are examples of recent activities related to Homeland Security preparedness:

With its unique location in downtown New York City, EML serves as a satellite team for the DOE Radiological Assistance Program (RAP) in Region I, which is operated out of DOE's Brookhaven Area Office.

EML is a member of the Federal Monitoring and Assessment Center (FRMAC) Laboratory Analysis Working Group. EML's role in the working group is to help define and support a performance evaluation program for DOE's analytical laboratories. These laboratories would be used to provide radiological data to define the extent and direction of contamination migration in a radiological emergency response.

In response to a request from the New York City Office of Emergency Management, EML presented a training module on "Radiation Basics and Radiation Detection" to managers and staff of New York City's emergency response infrastructure in Radiological Awareness and Planning.

*(Kevin.Miller@eml.doe.gov)*

### **Development of Standards and Roadmaps DHS TPO**

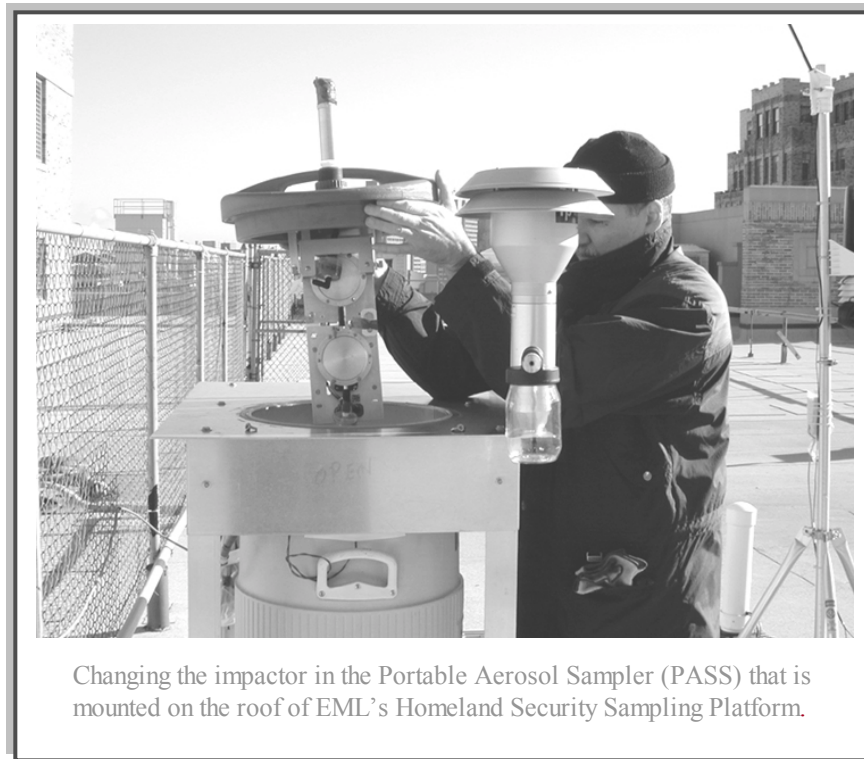
In FY 2002, EML was designated to transition to the proposed Department of Homeland Security (DHS). EML assisted the DHS Transition Planning Office (TPO) in planning activities for the Standards Program in the Science and Technology Directorate. EML staff provided expert radiation and radiological assistance for the development of roadmaps for the standards activities in the areas of equipment guidance documents, test protocols, test procedures, certification and training in the Radiation/Nuclear, Biological and Chemical thrust areas.

*(Raymond.Bath@eml.doe.gov)*



## Portable Aerosol Sampling System (PASS) EM

A Portable Aerosol Sampling System (PASS) is operating on EML's roof for collection and subsequent analysis of samples for various radionuclides. The sampler is configured to operate, with AC power and a large vacuum pump, for a period of 28 days. The impactor provides a continuous measurement of atmospheric aerosols in 2 size ranges, 0.2 to 2.5  $\mu\text{m}$  and 2.5  $\mu\text{m}$  to 10  $\mu\text{m}$ . A final filter, changed once a



Changing the impactor in the Portable Aerosol Sampler (PASS) that is mounted on the roof of EML's Homeland Security Sampling Platform.

week, collects particles below 0.2  $\mu\text{m}$ . The PASS filter provides a standard inlet (PM10) for ambient air concentration measurement. The samples being collected will: (1) improve the analytical capability at EML for quantifying picogram quantities of uranium; (2) provide a continuous background measurement of the aerosol composition; and (3) assess and improve the design of PASS. Should a homeland security disaster occur, PASS can provide a continuous record of the event as well as provide a background (prior to event) measurement.

*(Robert.Leifer@eml.doe.gov)*

## EML Homeland Security Monitoring Platform

In FY 2002, EML installed a homeland security monitoring platform on its roof in New York City, supporting a suite of instruments to provide vital information in the event of a terrorist attack. This set of measurement instrumentation, mounted on an 8 ft. by 10 ft. modular aluminum platform, is the first node in an envisioned network of sensors throughout New York City and all over the United States. This network would guide our nation's response to a nuclear or radiological attack by providing real-time information to federal, state and local officials on the location, movement and level of radioactive contamination. The platform could also easily accommodate sensors for chemical and biological agents.

*(Colin.Sanderson@eml.doe.gov)*

## Comprehensive Radiation Sensor (CRS)

The Comprehensive Radiation Sensor (CRS), a unique gamma radiation detector and spectroscopic analyzer, was developed by EML. The CRS responds within 2 seconds of detecting an elevated radiation level, alerting nearby personnel and sending out a network alarm, which can allow immediate intervention. The combination of rapid sampling and high sensitivity, which makes it an ideal area monitor, permits it to quickly detect any radioactive cloud. A network of many CRS units, linked together and connected to a central station, can provide wide geographic coverage, and also allow tracking the movement of these clouds.

In addition, CRS units can serve as low-cost portal monitors. By locating them at bridge and tunnel entrances or border entry points, they can detect the radiation from a vehicle carrying materials used to make a “dirty bomb.”



Because the CRS also supplies spectral data, it can identify the detected radioactive material and distinguish anthropogenic fission and activation from natural radiation. This important information can be extremely useful in minimizing radiological health effects and planning for effective remediation.

To keep costs and assembly time down, the CRS uses “off the shelf” components combined with inexpensive, unique detector housing made of PVC plastic pipe. Reliability, with no required maintenance, is inherent in the CRS, which operates automatically and unattended 24/7.

This system is fully operational, and a unit installed on EML's homeland security monitoring platform has been supplying data continuously since November 2001. Over 40,000 spectra have been recorded. Present and past data can be viewed at:

<http://www.eml.doe.gov/homeland/location.cfm>

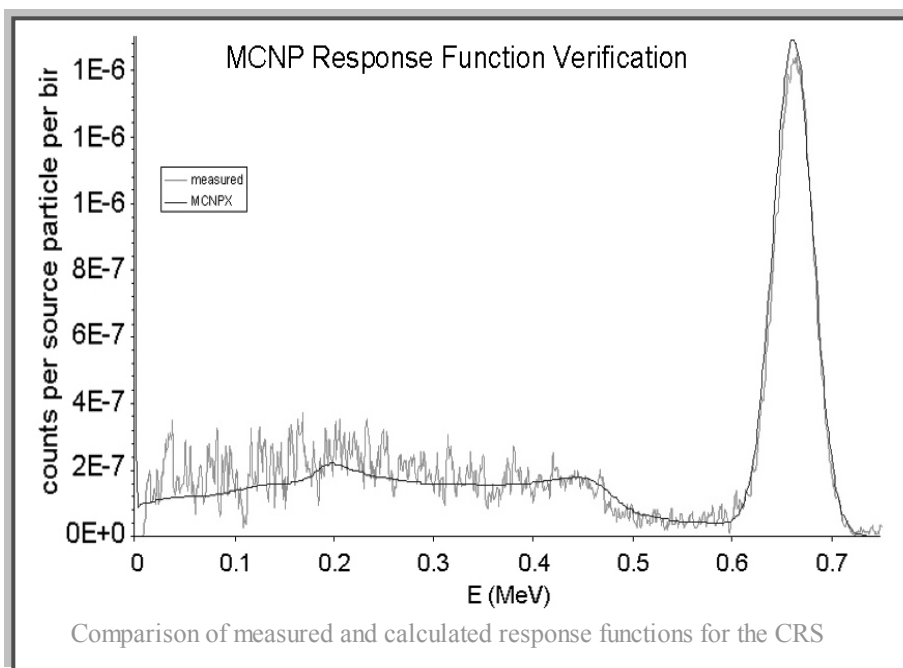
([Norman.Latner@eml.doe.gov](mailto:Norman.Latner@eml.doe.gov); [Norman.Chiu@eml.doe.gov](mailto:Norman.Chiu@eml.doe.gov))

## Real Time Gamma-Ray Spectrum Analysis

A data transfer system was constructed that transmits CRS gamma-ray spectra and ion chamber exposure rate measurements from the roof of 201 Varick Street directly to a real time web application. With the click of the mouse, the web page ([www.eml.doe.gov/homeland/](http://www.eml.doe.gov/homeland/)) displays this information as a plot of gross exposure rate through time and shows the results of spectral analysis at any given time.

The spectral analysis is performed using a weighted least squares algorithm that was modified to run in real time. Isotope specific response functions used in the spectral analysis were calculated using the transport code MCNP. The isotopes included isotopes found in natural fallout, isotopes found in

nuclear weapons fallout, and isotopes that may be used in a “dirty bomb.” The ability of MCNP to calculate the response functions was verified with a comparison with laboratory data, as shown in the figure. (*Paul.Bailey@eml.doe.gov*)



## NaI Based Neutron Detection

Experiments carried out during FY2002 showed that while a NaI crystal does respond to a neutron source, this response is not due to any neutron interactions in the crystal itself, but is instead due to a  $(n,\gamma)$  interaction in the scattering environment. This work paves the way for possible future work in modifications that can be made to a NaI crystal so that it does respond to neutrons, including such possibilities as adding a coating that converts neutrons to gammas. The results of these experiments will be published as an EML report in FY2003.

(*Paul.Bailey@eml.doe.gov*)

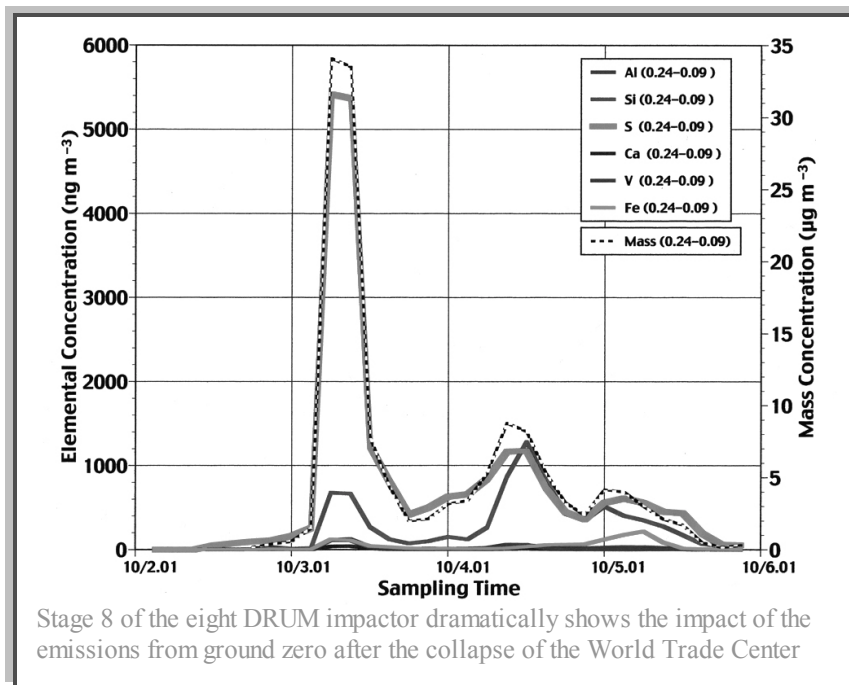
## Characterization of Plumes Passing Over Lower Manhattan After the World Trade Center Disaster

EPA

In response to the disaster at the World Trade Center (WTC), EML initiated a sampling program on its roof to characterize plumes passing over the building which is located approximately 2 km north of ground zero. The sampler, an eight-stage Davis Rotating Universal Size-Cut Monitoring Sampler (DRUM), operated on a 42-day cycle and provided three sets of drums for chemical analysis during the period from

October 2, 2001 to the end of December 2001. This sampler, on loan from the University of California, Davis was used for collecting low volume environmental samples for analysis of mass, optical aerosol properties, trace element concentration, organics and asbestos. Measurements of the ambient pressure, temperature, wind speed, wind direction and relative humidity were available from a meteorological system mounted on EML's roof. Samples were returned to the University of California, Davis where they were analyzed for optical properties, size and morphology, mass, hydrogen, elemental and organic concentrations. During the month of October 2001 (only data presently available), more than 25 plumes were detected passing over EML's building. The most dramatic occurred on October 3, 2001 when the mass concentration reached  $34 \mu\text{g m}^{-3}$  while the 3-hour concentration of sulfur in stage 8 ( $0.24$  to  $0.09 \mu\text{m}$ ) reached  $5.4 \mu\text{g m}^{-3}$  or 16% of the total mass. The characteristic of this plume, which lasted approximately 10 hours, was dominated by sulfur.

(Robert.Leifer@eml.doe.gov)



## **Impact of the World Trade Center Collapse on Hudson River/New York Harbor**

EML is collaborating with scientists from the University of Massachusetts in a National Science Foundation funded project to investigate the aquatic sediments of the Hudson River and New York Harbor after the collapse of the World Trade Center (WTC) towers. In October 2001 and July 2002, sediment cores were collected from areas of fine grained sediment accumulation in the Hudson River offshore from Manhattan and in the Upper Bay of New York Harbor. Chemical analyses are being performed to determine profiles of trace elements and organic combustion products in the sediment cores; electron microscopy is being used to look for visible evidence of WTC debris; and profiles of natural and artificial radionuclides are being determined by gamma-ray spectroscopy to establish deposition time scales for the sediment cores. Results to date show the presence of a layer of sediment containing microscopic gypsum and fiberglass fibers which originated from crushed office construction materials that blanketed a large area of lower Manhattan after the WTC collapse. Concentrations of copper and zinc in this same sediment horizon are enhanced relative to other sediment layers, suggesting a WTC origin for these trace element enhancements. The findings were published in EOS (Vol. 84, No. 3, January 2003). As results from additional sediment coring sites become available, the geographic extent of these chemical and physical markers of the WTC collapse in the sediments of the Hudson River and New York Harbor will be more clearly established.

*(John.Kada@eml.doe.gov)*

# CONSULTATION, PROGRAM MANAGEMENT, AND PROGRAM COORDINATION

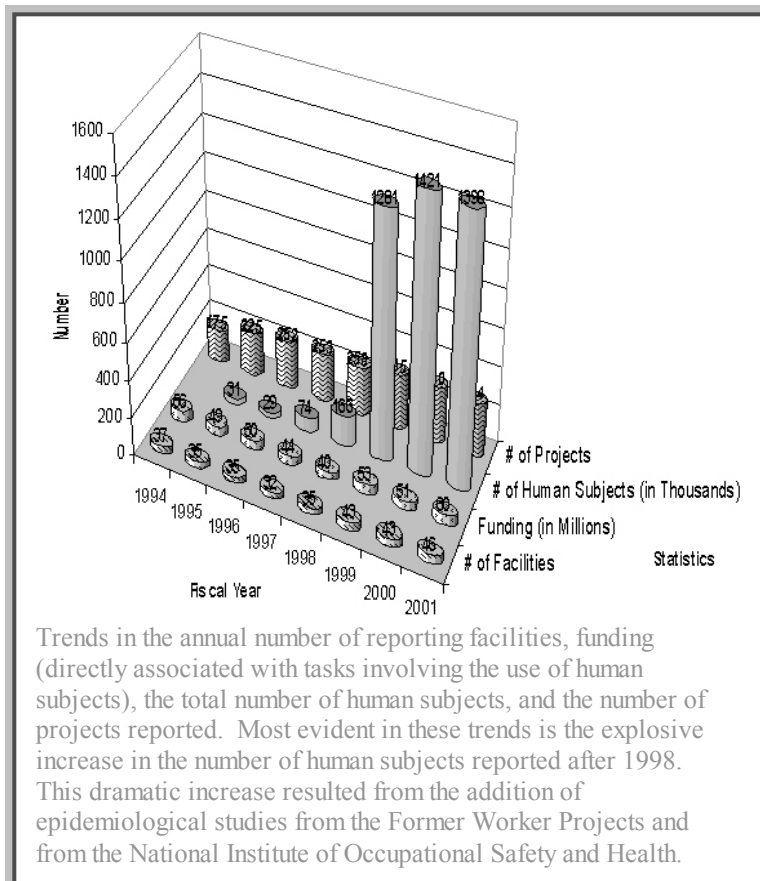
**As federal technical experts, EML provides accurate, unbiased, cost effective assistance**

*EML staff provides support to the Department of Energy and other government agencies in fulfilling important programmatic functions and responsibilities. As federal technical experts, the EML staff not only fulfills administrative roles, but also provides essential technical direction for several programs. EML staff are also members of several advisory committees and interagency working groups that help the Department maintain its high quality research and relevance in the areas of environmental radiation measurement and detection.*

## **Human Subjects Research Database (HSRD)** SC

EML maintains the HSRD for the Life Sciences Division (SC-72) in the Office of Science (SC). The database is an important reporting and quality assurance component of the Department's Protecting Human Subjects Program. DOE Order 443.1, "Protection of Human Subjects," requires that specific information about research projects that involve human subjects that were funded by DOE, conducted at DOE facilities, or performed by DOE personnel, are reported annually in the HSRD.

EML is responsible for creating, annually updating, maintaining and ensuring the quality of the database. EML also provides related software development and participates in the Human Subjects Working Group. The database can be accessed from EML's web site.  
([Richard.Larsen@eml.doe.gov](mailto:Richard.Larsen@eml.doe.gov))



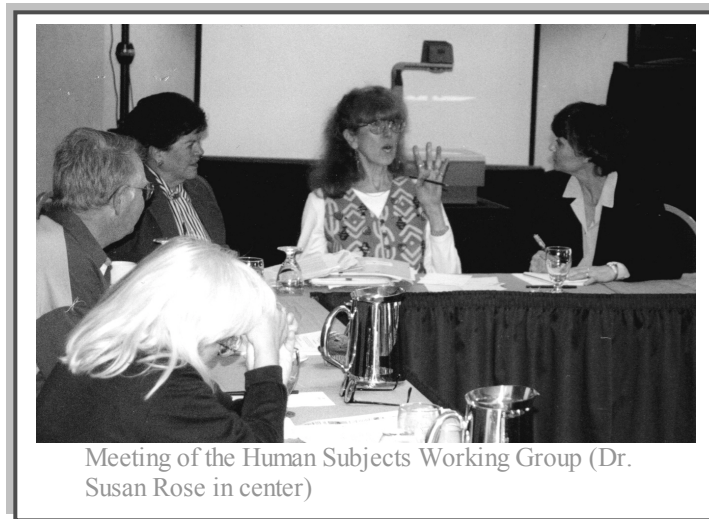


## **Special Assistance to the DOE Protecting Human Subjects Program**

### **SC**

EML provided special assistance to Dr. Susan Rose, Program Manager of the Protecting Human Subjects Program. Coordination and on-site assistance was provided for the annual DOE Human Subjects Working Group Meeting in Grand Junction, CO, and a special topical human subjects protection conference entitled “The Community IRB Member: Neighbor and Partner,” in Gaithersburg, MD. Support for

other working group activities and conference calls, and the writing of educational materials and guidebooks is also provided. (*Ethel.Jacob@eml.doe.gov*)



## **D&D Science Consortium**

### **EM**

EML teamed with The Oak Ridge Institute for Science and Education (ORISE), the Argonne National Laboratory (ANL), and the Idaho National Engineering and Environmental Laboratory (INEEL) to form the Decontamination and Decommissioning Science Consortium. A web site was created (<http://www.ornl.gov/ddsc>) where D&D professionals can obtain information on decommissioning news, D&D technologies, regulatory guidance, dose modeling, survey instrumentation, and MARSSIM. The site also features an “Ask an Expert” interactive forum to answer questions on D&D subjects. (*Kevin.Miller@eml.doe.gov*)

## **EM Headquarters – EML Liaison**

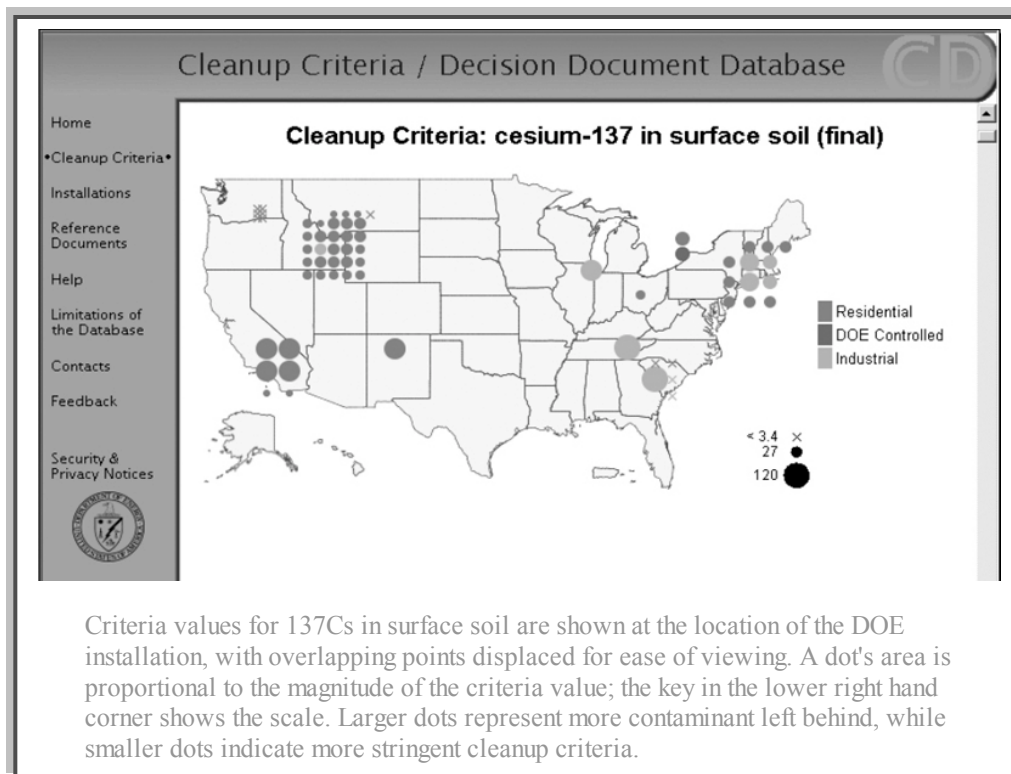
### **EM**

EM-50 (OST - Office of Science and Technology) has managerial oversight of all EM laboratories, including RESL, INEEL (Idaho) and SRTC (Savannah River), as well as EML. In order to insure that EML is well-integrated into the EM mission, an EML scientist served on detail at DOE Headquarters in Washington over the past several years. This provided OST with an understanding of EML’s capabilities and enabled EML to work on projects of major EM concern. (*Alfred.Cavallo@eml.doe.gov*)

## Cleanup Criteria/Decision Document (C2D2) Database EM

The C2D2 database is a central source of information on DOE cleanup agreements. The data is drawn from regulatory compliance documents such as Records of Decision and internal DOE reports; it is applicable to future cleanup negotiations and complex-wide assessments. The database includes more than 50 data elements such as the residual concentration of individual contaminants that will remain after cleanup is complete (“cleanup criteria”), background concentration, land use, response action, and site information for 500 DOE remediation sites. Since 1999, EML has been responsible for managing and upgrading the C2D2 database and is working in collaboration with Argonne National Laboratory.

In FY 2002, EML released a new internet interface that makes it easier for users to access the C2D2 data (<http://c2d2.eml.doe.gov>). Through the interface, users may search the database for an installation or contaminant of interest. Graphical displays illustrate distributions, variations and trends; interactive drill-down features reveal more details. Summary information is available in table format and, where available, a link is provided to an electronic copy of the decision document. The C2D2 web site averages about 600 visits and 5000 hits (clicks to various links) per month. Also in FY 2002, EML authored a paper on the new user interface that has been submitted for publication review. (*Gladys.Klemic@eml.doe.gov*)





## **Validation of Subsurface Bayesian Geostatistical Survey Analysis**

NRC

EML is developing augmented statistical procedures to support innovative survey protocols to evaluate extremely low decontamination levels that approach background levels and are necessary to resolve limitations in the existing MARSSIM survey designs. EML is working with the Nuclear Regulatory Commission (NRC) to incorporate Bayesian geostatistical methods into a version of the SADA (Spatial Analysis and Decision Assistance) software being developed by the University of Tennessee. The challenge is to incorporate prior knowledge of site contamination into a form that can be used to reduce the amount of sampling necessary to characterize, remediate, and release sites with known or suspected subsurface contamination. The goal is a functional program for conducting defensible technical calculations for designing and analyzing surveys of subsurface radioactive contamination in heterogeneous geometric configurations below the soil surface. *(Carl.Gogolak@eml.doe.gov)*

## **Radiological Evaluation Assistance**

NRC

In FY 2002, EML provided assistance to the Nuclear Regulatory Commission Headquarters and Regional Offices relating to the decommissioning of nuclear facilities. This assistance included the review of decommissioning-related documents and laboratory-based analysis of soil and water samples for a variety of radionuclides. *(Peter.Shebell@eml.doe.gov)*

## **Characterization, Monitoring and Sensor Technology Cross-Cutting Program (CMST-CP)**

EM

Since 1991, the CMST-CP has provided innovative technology solutions to support the cleanup and long-term stewardship of EM sites. Since 1997, EML has supported the CMST-CP Technical Management team by providing a Liaison to the Deactivation and Decommissioning Focus Area (DDFA). In this position, EML participated in strategic planning, implementation, and management of EM/OST research and development programs. The major focus of FY 2002 activities was the completion of a beryllium air and swipe monitor by Science & Engineering Associates, Inc. (SEA), a demonstration of the technology at Rocky Flats, and a deployment at Paducah. At the many DOE sites now required under the Chronic Beryllium Disease Prevention Program (10CFR Part 850) to institute a beryllium measurement program, it is anticipated that the real-time monitor will provide substantial cost savings compared to the baseline method swipe sampling and subsequent laboratory analysis. *(Adam.Hutter@eml.doe.gov)*

## **Joint Coordinating Committee on Environmental Restoration and Waste Management (JCCEM)**

EM

The Russian Ministry of Atomic Energy (MINATOM) and DOE have been cooperating for more than ten years on many different aspects of mutually beneficial environmental management issues. The JCCEM is the managing body of this formal Memorandum of Cooperation, operating under the umbrella of the Peaceful Uses of Atomic Energy Act. For much of this time, an EML Technical Program Manager (TPM) has led the Site Characterization and Contaminant Transport Area of Cooperation within the JCCEM, which utilizes Russian data and expertise of groundwater contaminant transport at Russian nuclear sites. The TPM is responsible for the strategic planning and coordination of the American and Russian projects, ultimately ensuring that the technical direction of the program is beneficial to EM site cleanup activities. During FY 2002, the major activity for the TPM was the closeout of activities focused on understanding contaminant transport at the Mayak site, the data from which will help to calibrate and validate transport models in use at DOE sites. With the changing emphasis in the Environmental Management R&D program, the TPM also worked to find additional resources for FY 2003 and beyond concerning studies at the Tomsk site where liquid radioactive waste was injected into deep wells as a test disposal method. (*Adam.Hutter@eml.doe.gov*)

## **Interstate Technology and Regulatory Cooperation (ITRC) Coalition**

EM

In FY 2002, EML continued its contribution to the ITRC as a member of the Sampling, Characterization, and Monitoring Team. The ITRC is a state-led national coalition whose mission is to create tools and strategies to reduce interstate barriers to the deployment of innovative environmental technologies. ITRC receives over 60% of its funds from DOE. As part of the Sampling, Characterization, and Monitoring Team, EML will contribute a case study on the efforts of the Real-Time Measurement Group and the use of the Integrated Technology Suite at the Fernald Environmental Management Project to an ITRC guidance document on the Triad Approach, which is a site remediation strategy developed by EPA's Technology Innovation Office. This effort will help inform and educate state regulators on innovative characterization techniques for soils developed by FEMP. (*Peter.Shebell@eml.doe.gov*)

## **U.S. Transuranium and Uranium Registries (USTUR) Advisory Committee**

EM

The USTUR performs actinide measurements on tissues from donated occupational worker cases. The analytical results are used to test the validity of radiation protection models used throughout the DOE complex, as well as the dose model developed by the International Commission on Radiological Protection. The seven member Advisory Committee meets annually and participates in quarterly conference calls. The Committee

advises the USTUR on the direction of work in progress as well as envisioned work scopes. EML has participated as a committee member for five years functioning in the dual roles of radiochemistry expert and DOE representative to the Committee.

*(Isabel.Fisenne@eml.doe.gov)*

### **Textbook on Radioanalytical Chemistry**

NN

EML serves on the Editorial Advisory Board for the “Textbook on Radiochemistry.” This work is being sponsored under a Nonproliferation and National Security University Research Initiative that seeks to preserve key findings in the field of radiochemistry developed as an outgrowth of the U.S. nuclear weapons programs. Either first drafts or comprehensive outlines have been submitted for all chapters. An independent review of this project is scheduled for FY 2003.

*(Isabel.Fisenne@eml.doe.gov)*

### **Strategic Environmental Research and Development Program (SERDP)**

SC

EML continued its role as SERDP Technical Coordinator for all Departmental activities for DOE Offices (SC, EM, DP, NNSA, and others) and the National Laboratories with the DoD, EPA, and other federal agencies partnering with SERDP. FY 2002 activities included developing the statement of needs related to the DOE/DoD mission for projects to be funded by SERDP, providing guidance for the fiscal year program, reviewing and selecting proposals, and reviewing SERDP new-start and continuing research projects. In addition, EML also participates as EM representatives on the “Compliance” and “Conservation” Technical Thrust Area Working Groups. *(Merrill.Heit@eml.doe.gov)*

### **Interagency Arctic Research Policy Committee (IARPC)**

SC

EML continued to provide staff representation for DOE at all IARPC meetings to ensure coordination of Arctic research activities with other federal agencies. In addition, the EML staff representative prepared all required IARPC-related reports for the Department, including the “Annual Overview of Agency (DOE) Arctic Research – Program Descriptions.” EML also serves as a member of the IARPC-related multi-agency Working Group on the “Study of Environmental Arctic Change.”

*(Merrill.Heit@eml.doe.gov)*

# AWARDS AND RECOGNITION

## EML Scientist Receives Japanese Research Award

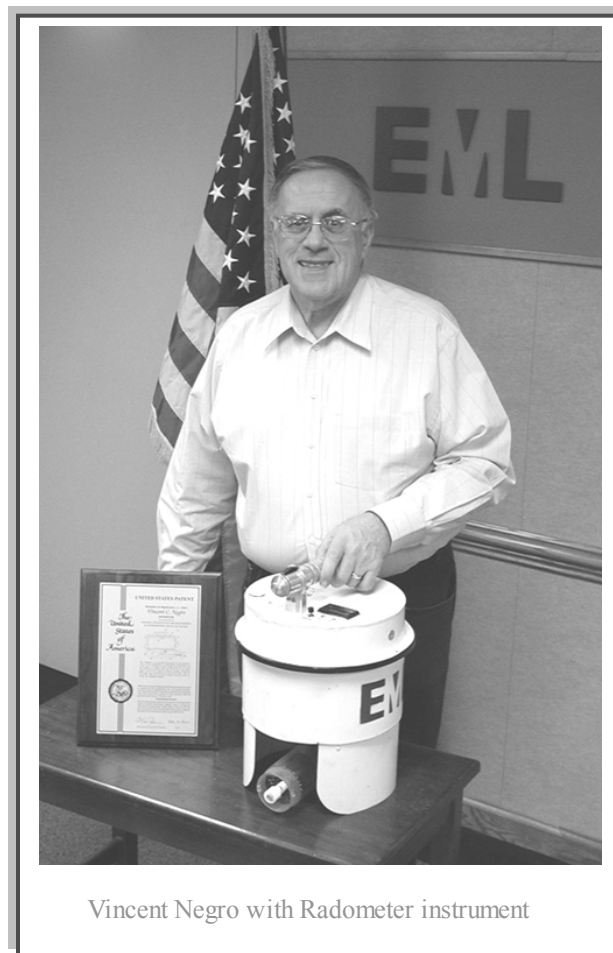
Dr. Hsi-Na (Sam) Lee was sponsored by the Ministry of Education, Culture, Sports, Science and Technology in Japan, under the research award, “Foreign specialists in the comprehensive, basic study field of atomic energy,” to visit again the Meteorological Research Institute (MRI) in Japan from December 24, 2001 – March 23, 2002. As part of the research award for visiting scholars, Dr. Lee visited the Low Level Radioactivity Laboratory in the University of Kanazawa, Kanazawa, Japan and the Japan Meteorological Agency in Tokyo. The objectives of the visit were to work with scientists at MRI to improve continually the model calculations of long-range transport of atmospheric radionuclides and Asian dust by taking into account the resuspension processes that are important to sites in the DOE complex, particularly those in the dryer regions such as Rocky Flats and the Nevada Test Site. Collaborations between EML and MRI will continue in FY 2003.

*(Sam.Lee@eml.doe.gov)*

## EML Scientist Awarded Patent

Vincent C. Negro was awarded a patent on the Radometer (Patent No. US 6288400B1), a battery-operated instrument that measures the radioactive gases radon and thoron in real time. Unlike all other instruments, which use a pump and filter paper to remove progeny, the Radometer employs a dual electric field concept which eliminates the pump/filter. This allows the Radometer to be supplied by 3 flashlight batteries which are held in the handle of the instrument, enabling easy replacement. Sophisticated analog and digital circuits are controlled by the onboard computer, making the instrument very easy to use. Therefore, in addition to scientific applications, the Radometer can be used by the real estate industry to immediately inform prospective home buyers of radon levels.

*(Vincent.Negro@eml.doe.gov)*



Vincent Negro with Radometer instrument

# STAFF ACTIVITIES

- Visiting Scientists
- Technical Seminars by Visiting Scientists
- Technical Presentations by EML Staff
- Presentations at Scientific Meetings
- Training
- Academic Affiliations and Activities
- Committee and Outside Coordination Activities (National and International)
- Professional Society Activities
- Standards Activities
- Meetings Organized and Sessions Chaired
- Publications

## VISITING SCIENTISTS

*As always, EML received many official visitors from all corners of the world, generally for periods of just a day or two. The following scientists worked/trained at EML for longer periods:*

Shinji Tokonami and Tetsuo Ishikawa

National Institute of Radiological Sciences, Japan (March 4-8, 2002)

Shilu Wang and Guojiang J. Wan

Chinese Academy of Sciences, People's Republic of China (April 3-9, 2002)

Trung Van Huynh

Vietnam Atomic Energy Commission, Vietnam (May 5-15, 2002)

## TECHNICAL SEMINARS BY VISITING SCIENTISTS

*The seminar program at EML by visiting scientists keeps the scientific staff informed on programs and research in other institutions.*

Scott Mallette and Steve Centore, Brookhaven Area Office

“Overview of RAP”

June 27

George Hendrey, Brookhaven National Laboratory

“A Real-Time Monitoring Network for Atmospheric Contaminants in New York City”

July 26

Trung Van Huynh, Vietnam Atomic Energy Commission

“Activities in Analytical Chemistry at the Vietnam Atomic Energy Commission”

August 15

Fred Booth, WPI

“Internet-Based Gamma Evaluation Program”

September 13

Charles Gentile, Princeton Plasma Physics Laboratory

“The Development and Capabilities of the Miniature Nuclear Detection System (MINDS)”

September 24

## **TECHNICAL PRESENTATIONS BY EML STAFF**

*Presentations at EML keep the scientific staff informed of progress in programs in the Laboratory:*

Mitchell D. Erickson

“Technical Information for Long-Term Surveillance and Monitoring

Raymond Bath

“SAMPLES - A PBMS Approach to the Data Review Process”

Anna Berne

“Advanced Photon Source at Argonne National Laboratory-Synchrotron Environmental Science”

Hsi-Na (Sam) Lee and Colin Sanderson

“Asian Adventures”

Raymond Lagomarsino

“An Improved Method for the Calculation of Strontium-90 Activity in QAP Samples”

Paul Bailey

“Comprehensive Radiation Sensor (CRS) Calibration”

Hsi-Na (Sam) Lee

“EML’s Role in Atmospheric Modeling for Homeland Security”

Ada Kong

“Mass Spectrometry and Homeland Security”

## **PRESENTATIONS AT SCIENTIFIC MEETINGS**

Richard Larsen

“EML Initiatives in Long-Term Stewardship”

Annual Workshop on Environmental Monitoring in the DOE-Complex, Brookhaven National Laboratory, October 2001

Anna Berne

“Evaluation of Soil Samples for Pu-238, Pu-239/240, Am-241 and Sr-90: An International Cooperative Training Exercise”

Radiochemical Measurements Conference, Honolulu, Hawaii, November 2001

Carl Gogolak

“DQOs and the Development of MQOs”

Radiochemical Measurements Conference, Honolulu, Hawaii, November 2001

Adam Hutter

“CMST-CP FY02 Activities for the Deactivation and Decommissioning Focus Area”  
FY 2002-Kick-Off Meeting of the Characterization, Monitoring and Sensor Technology  
Cross-Cutting Program (CMST-CP), Albuquerque, New Mexico, November 2001

Hsi-Na (Sam) Lee

“EML’s Global Network of Measuring Surface Air Radionuclides and Its Applications for  
Atmospheric Studies”

Low-Level Radioactivity Laboratory, Kanazawa University, Kanazawa, Japan, January 2002

Hsi-Na (Sam) Lee

“EML’s Global Network of Measuring Surface Air Radionuclides and Its Applications for  
Atmospheric Studies”

Japan Meteorological Agency, Tokyo, Japan, February 2002

Carl Gogolak

“Sign Test Versus WRS Test”

35<sup>th</sup> Midyear Meeting of Health Physics Society Symposium, Orlando, Florida, February 2002

Hsi-Na (Sam) Lee

“Simulation of Global Transport of Dusts by Using the Improved MRI’s Global Transport  
Model”

Meteorological Research Institute at Tsukuba in Japan, February 2002

Mitchell D. Erickson

“Technical Information for Long-Term Surveillance and Monitoring”

Waste Management 2002 Conference, Tucson, Arizona, February 2002

Adam Hutter

“International Characterization Projects”

Office of Environmental Management’s Office of Science and Technology, Subsurface  
Contaminants Focus Area Mid-Year Review, March 2002

Hsi-Na (Sam) Lee

*Invited:* “Atmospheric Studies Using Radionuclides as Tracers”

Third Annual Meeting of “Environmental Radioactivity,” Tsukuba, Japan, March 2002

Raymond Bath

*Invited:* “EML SAMPLES”

EPA Interagency Data Quality Task Force and EPA Quality Assurance Meeting, Phoenix,  
Arizona, April 2002

Mitchell D. Erickson

“Management of 9/11: A Very Local Account”

DOE Site /Area Office Laboratory Managers Meeting, Richmond, Washington, April 2002



Paul Goldhagen

“Recent Results From Measurements of the Energy Spectrum of Cosmic-Ray Induced Neutrons Aboard an ER-2 Airplane”

American Nuclear Society Radiation Protection and Shielding 2002 Topical Meeting,  
Santa Fe, New Mexico, April 2002

Colin Sanderson

“EML’s Intelligent Radiation Detector System for Remote Monitoring”

Workshop on Unattended Radiation Sensor Systems for Remote Applications, Washington, DC,  
April 2002

Catherine S. Klusek

“Project Planning and Project Plans”

EPA Science Advisory Board, Multi-Agency Radiological Laboratory Analytical Protocols  
Manual (MARLAP) Meeting, Washington, DC, April 2002

Carl Gogolak

“Linking Data Quality Objectives to Measurement Quality Objectives”

EPA Science Advisory Board, Multi-Agency Radiological Laboratory Analytical Protocols  
Manual (MARLAP) Meeting, Washington, DC, April 2002

Matthew Monetti

*Invited:* “Highlights of the 12<sup>th</sup> International Intercomparison of Environmental Dosimeters”  
Harshaw TLD Users’ Group Symposium, San Antonio, Texas, May 2002

Paul Goldhagen

“Radiation Basics and Radiation Detection”

Radiological Awareness and Planning Training at NYC Office of Emergency Management,  
New York, New York, May 2002

Isabel Fisenne

“Stratospheric Radon Measurements in Three North American Locations”

Natural Radiation in the Environment (NRE VII), Rhodes, Greece, May 2002

Ada Kong

“Comparison of ICP-MS with Two Uranium Measurement Methods for the Quality  
Assessment Program”

50<sup>th</sup> American Society for Mass Spectrometry Conference, Orlando, Florida, June 2002

Peter Shebell

*Invited:* “Performance Standard on the Calibration of Germanium Detectors for *In Situ* Gamma-  
Ray Measurements”

47<sup>th</sup> Annual Meeting of the Health Physics Society, Tampa, Florida, June 2002

Peter Shebell

*Invited:* “A Historical Perspective on the Applications of *In Situ* Gamma-Ray Spectrometry”  
(Kevin Miller co-author)

47<sup>th</sup> Annual Meeting of the Health Physics Society, Tampa, Florida, June 2002

Carl Gogolak

“Data Quality Objectives and the Development of Measurement Quality Objectives”

47<sup>th</sup> Annual Meeting of the Health Physics Society, Tampa, Florida, June 2002

Adam Hutter

“Innovative Characterization Technologies in Support of DOE/EM D&D Activities”

Spectrum 2002, Reno, Nevada, August 2002

Carl Gogolak

*Invited:* “MARSSIM”

Annual Meeting of U.S. Army Corps of Engineers Radiation Safety Support Team,  
Cleveland, Ohio, August 2002

Pamela Greenlaw

“Quality Assurance for the Noble Gas Measurement Systems”

International Monitoring System Radionuclide Laboratory Workshop, Vienna, Austria  
August 2002

Hsi-Na (Sam) Lee

“EML’s Global Network of Measuring Surface Air Radionuclides and Their Analyses”

International Conference on Radioactivity in the Environment, Monaco, September 2002

Raymond Bath

“SAMPLES Program”

2002 National Analytical Management Program (NAMP) Meeting, Las Vegas, Nevada,  
September 2002

Raymond Bath

“SAMPLES BNL/EPA Proof-of-Concept Study:

2002 National Analytical Management Program (NAMP) Meeting, Las Vegas, Nevada,  
September 2002

Anna Berne

“The Use of EML’s QAP Data in Accelerating the EM Cleanup Program”

2002 National Analytical Management Program (NAMP) Meeting, Las Vegas, Nevada,  
September 2002

Raymond Bath

“Certification of Instruments”

Workshop on Radiological Dispersal Device and Nuclear Standards for First Responders,  
Washington, DC, September 2002

## **TRAINING**

*EML scientists provide training courses to DOE and contractor personnel, as well as other federal and state agencies*

Carl V. Gogolak

MARSSIM - (in conjunction with EPA)  
Kansas City, Missouri (May 20-24, 2002)  
Seattle, Washington (June 3-7, 2002)

Paul Goldhagen

Radiological Awareness and Planning - Module on “Radiation Basics and Radiation Detection” at NYC Office of Emergency Management (May 31, 2002)

## **ACADEMIC AFFILIATIONS AND ACTIVITIES**

Isabel M. Fisenne

Associate Adjunct Professor, School of Environmental Medicine, New York University

Vincent C. Negro

Adjunct Associate Professor, Queensborough Community College, City University of New York

Saby Tavales

Instructor, Pace University

## **COMMITTEE AND OUTSIDE COORDINATION ACTIVITIES (National and International)**

Anna Berne

Voting Delegate - National Environmental Laboratory Accreditation Conference (NELAC)

Member, National Analytical Management Program Steering Committee Working Group on “Development of Quantitative Laboratory Performance Evaluation Program”

Alfred Cavallo

Member, Strategic Environmental Research Development Program (SERDP) Technical Thrust Area Working Group on “Compliance”

Member, Technology Subgroup of Container Working Group Workshop

Mitchell D. Erickson

Member, National Analytical Management Program (NAMP) Steering Committee

Member, Executive Team, DOE Environmental Measurements Core Laboratories

Isabel M. Fisenne

Member, Editorial Advisory Board, “Textbook on Radiochemistry”

Member, Advisory Committee to the United States Transuranium and Uranium Registries (USTUR)

Carl V. Gogolak

Member, Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP) Work Group

Member, Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM) Work Group

Paul Goldhagen

Member, Joint Task Group on Reference Doses from Cosmic Ray Exposure for Aircrew of the International Commission on Radiological Protection/International Commission on Radiation Units and Measurements (ICRP/ICRU)

Member, Working Group 21 on Dosimetry for Exposures to Cosmic Radiation in Civilian Aircraft of the International Organization for Standardization (ISO)

Pamela D. Greenlaw

Member and Chair, Chapter on “Radiological Data Verification and Validation,” Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP)

Merrill Heit

DOE Staff Representative to Interagency Arctic Research Policy Coordinating Committee (IARPC)

DOE Staff Representative to Interagency Working Group for the Study of Environmental Arctic Change (SEARCH)

DOE Technical Coordinator for the Strategic Environmental Research Development Program (SERDP)

Adam Hutter

Member, Strategic Environmental Research Development Program (SERDP) Technical Thrust Area Working Group on Conservation

Liaison for Deactivation and Decommissioning Focus Area, Characterization, Monitoring & Sensor Technology Crosscutting Program (CMST-CP)

Member, Mound Long-Term Stewardship Initiative Technology Team

Member, User Group for the National Center for Combating Terrorism

Catherine S. Klusek

Member, Pueblo Technical Advisory Group

Member and Chair, Chapters on “Directed Planning,” “Project Plan Documents,” and Data Quality Assessment,” Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP)

Richard Larsen

Member, Strategic Environmental Research Development Program (SERDP) Technical Thrust Area Working Group on “Compliance”

Colin Sanderson

Member, DOE/OHS TPO Counterterrorism Council

Peter Shebell

Member, Sampling, Characterization and Monitoring Team of Interstate Technology and Regulatory Cooperation

## **PROFESSIONAL SOCIETY ACTIVITIES**

Ada Kong

President, Chinese American Society of Mass Spectrometry

## **STANDARDS ACTIVITIES**

Isabel M. Fisenne

Member, Committee on Nuclear Fuel Cycle, Task Group on Environmental Methods, ASTM C26.05

Pamela D. Greenlaw

Member, Subcommittee on “Radiochemical Methods of Analysis for Water and Water Deposits,” ASTM D19.04

Gladys Klemic

Chair, Working Group on “American National Standard for Environmental Thermoluminescent Dosimeters,” ANSI N13.37

Peter Shebell

Member, Writing Group, “Standard for *In Situ* Gamma-Ray Spectrometry,”  
ANSI N42.RM Subcommittee

Co-Chair, Writing Group, “Performance Standard for the Calibration of Germanium  
Detectors for *In-Situ* Gamma-Ray Measurements, ANSI N42.28”

### **MEETINGS ORGANIZED AND SESSIONS CHAIRED**

Mitchell D. Erickson

Co-Organized session on Long-Term Stewardship at Spectrum 2002 International  
Conference on Nuclear and Hazardous Waste Management, Reno, Nevada  
(August 4-8, 2002)

Carl Gogolak

Organized and co-chair special MARLAP Session (Multi-Agency Radiological  
Laboratory Analytical Protocols Manual) at Annual Health Physics Society Meeting,  
Tampa, Florida (June 16-20, 2002)

Pamela Greenlaw

Co-Organizer of Workshop - New York Metropolitan Region: Counterterrorism and  
Infrastructure Assurance Technology Needs, US Merchant Marine Academy,  
Kings Point, New York, and EML (April 9-11, 2002)

Adam Hutter

Member, Technical Program Committee, 6<sup>th</sup> International Conference on Methods and  
Applications of Radioanalytical Chemistry (MARC VI)

Catherine Klusek

Co-Organizer and Moderator, QA/QC Workshop, 47<sup>th</sup> Annual Radiochemical  
Measurements Conference, Honolulu, Hawaii (November 4-8, 2001)

## **EML PUBLICATIONS**

10/01/2001 to 9/30/2002

Reginatto, M.

"Resolving Power of a Multisphere Neutron Spectrometer"

Nucl. Instrum. Meth. A, Vol. 480, pp. 690 - 695, July 2002

Greenlaw, P. D., and A. Berne

"Semi-Annual Report of the Department of Energy, Office of Environmental  
Management Quality Assessment Program"

USDOE Report EML-617, June 2002

Erickson, M. D.

"Long-Term Stewardship Panel Discussion at the Third Dixy Lee Ray Memorial  
Symposium"

Technology, Vol. 8, pp. 324 - 325, May 2002

Latner, N., N. Y. Chiu, and C. G. Sanderson

"An Intelligent Radiation Detector System for Remote Monitoring"

Proceedings of the Workshop on Unattended Radiation Sensor Systems for Remote  
Applications, April 2002

Beck, H. L., and B. Bennett

"Historical Overview of Atmospheric Nuclear Weapons Testing and Estimates of Fallout  
in the Continental United States"

Health Phys., Vol. 82, pp. 591 - 608, April 2002

Bennett, B. G.

"Worldwide Dispersion and Deposition of Radionuclides Produced in Atmospheric  
Tests"

Health Phys., Vol. 82, pp. 644 - 655, April 2002

Miller, K. M., and R. J. Larsen

"The Development of Field-Based Measurement Methods for Radioactive Fallout  
Assessment"

Health Physics, Vol. 82, pp. 609 - 625, April 2002

Erickson, M. D., and A. J. Cavallo

"Technical Information for Long-term Surveillance and Monitoring"

Proc. 28th Annual Waste Management Conf., College of Engineering and Mines, The  
University of Arizona, AZ, March 2002

Lin, Z., A. Berne, B. Cummings, K. G. Inn, and J. Filiben

"Competence of Alpha Spectrometry Analysis Algorithms Used to Resolve the Am-241  
and Am-243 Alpha Peak Overlap"

J. Applied Radiation and Isotopes, Vol. 56, pp. 57 - 63, February 2002

Erickson, M. D.  
"EML FY 2001 Annual Report"  
USDOE Report EML-616, February 2002

Goldhagen, P., M. Reginatto, T. Kniss, J. W. Wilson, R. C. Singleterry, I. W. Jones, and W. Van Stevenick  
"Measurement of the Energy Spectrum of Cosmic-ray Induced Neutrons Aboard an ER-2 High-altitude Airplane"  
Nucl. Instruments & Methods in Physics Res., A, Vol. A 476, pp. 42 - 51, January 2002

Reginatto, M., P. Goldhagen, and S. Neumann  
"Spectrum Unfolding, Sensitivity Analysis and Propagation of Uncertainties with the Maximum Entropy Deconvolution Code MAXED"  
Nucl. Instruments & Methods in Physics Res., A, Vol. A 476, pp. 242 - 246, January 2002

Erickson, M. D.  
"PCB Properties, Uses, Occurrence, and Regulatory History"  
L. W. Robertson, and L. G. Hanson (Editors)  
Introduction: PCB Properties, Uses, Occurrence, and Regulatory History, Vol. ISBN 0-818, pp. 1 - 22, December 2001

Greenlaw, P. D., and A. Berne  
"Semi-Annual Report of the Department of Energy, Office of Environmental Management, Quality Assessment Program"  
USDOE Report EML-615, December 2001

Englemann, R., H. Beckert, P. Coffin, H. Duvall, R. Emons, W. Harrell, P. Kesich, C. S. Klusek, A. Lee, R. Loube, and J. Ordaz  
"A Guide to Beginning an Environmental Program"  
U. S. Department of Energy, National Nuclear Security Administration, November 2001

Klemic, G., and D. Elcock  
"The Cleanup Criteria/Decision Document (C2D2) Database"  
Center for Risk Excellence Progress Report, DOE Chicago Operations Office, Argonne, IL, DOE/CH/CRE-5-2001, October 2001

Erickson, M. D.  
"Environmental Measurements Laboratory 2002 Unit Performance Plan"  
USDOE Report EML-614, October 2001





**Environmental Measurements Laboratory**  
**U. S. Department of Energy**  
**201 Varick Street, 5th floor, New York, NY 10014-4811**  
**<http://www.eml.doe.gov>**

